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NUECES BBASC STUDY #3

NUECES WATERSHED
PRE- AND POST-DEVELOPMENT
NUTRIENT BUDGETS

NUECES ESTUARY ADVISORY COUNCIL
JUNE 22, 2015
PAULA JO LEMONDS, PE, PG

DISCUSSION

Background

Status

Results

Schedule

BACKGROUND

- Nueces BBASC work plan
  - Tier 2b Recommendation
- Nueces BBEST
  - BBEST Recommendations Report
    - Sec. 5.2 Nutrient Considerations
- Nueces BBASC
  - BBASC Recommendations Report
    - Sec. 4.3.2 Nutrient Considerations

GOALS

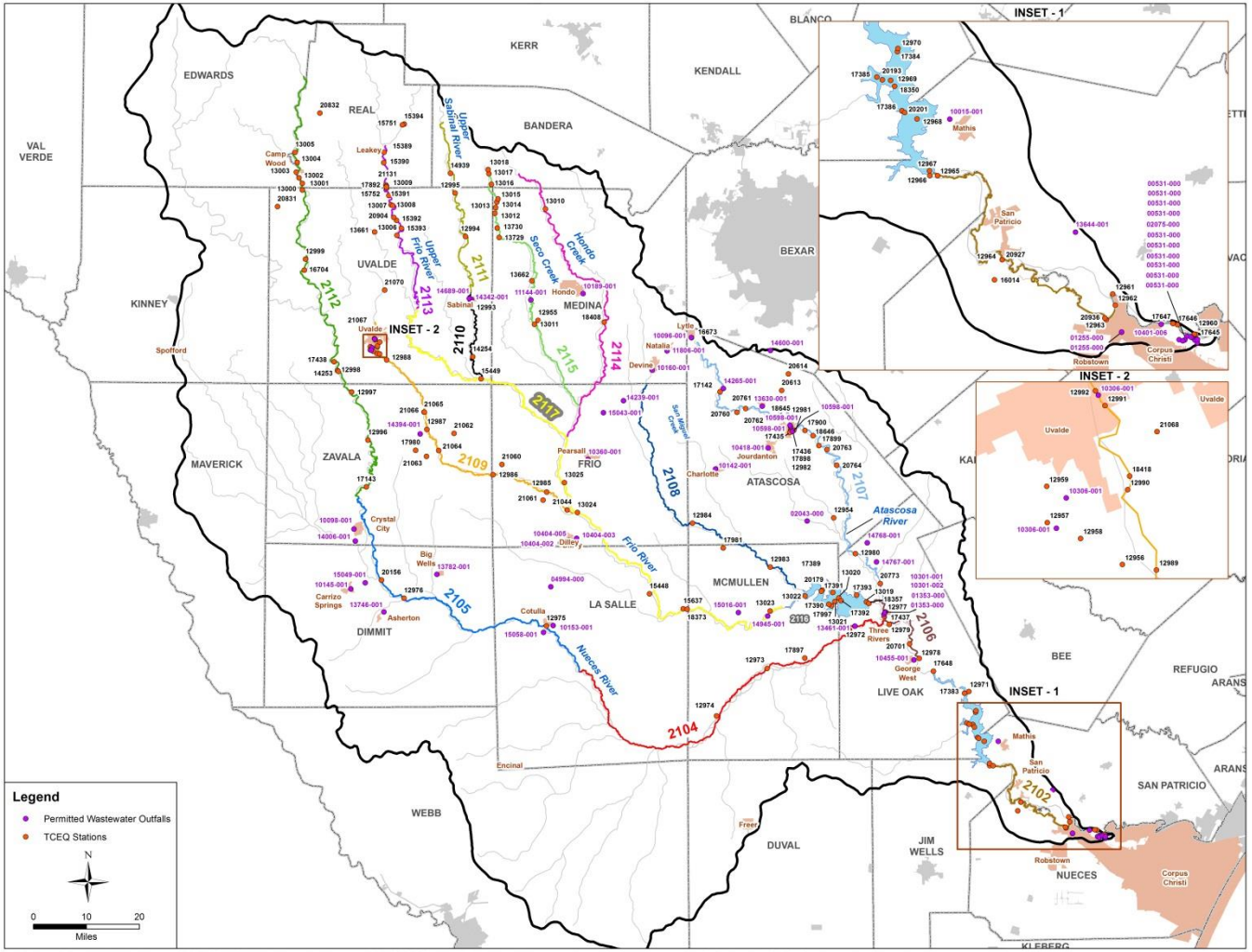
- Develop nutrient budgets based on quantitative understanding of natural supply of all nutrient forms and anthropogenic changes in these supplies over time for Nueces Bay watershed

- Determine annual loads for both the pre-development and present condition

Source: Nueces BBASC work plan

SCOPE OF WORK

- Task 1 – Compile Data
  - Compile Water Quality and Hydrologic Data
- Task 2 – Perform Data Evaluation and Modeling Analyses
  - Perform Data Evaluation
    - Available data, sampling stations, and subwatersheds
    - Identify appropriate stations
  - Refine Linear Regression Analyses
  - Estimate Reservoir Influence Sink/Sources
  - Water Quality Correlations to Anthropogenic Changes
  - Pre- and Post-Development Loadings



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ANALYSES

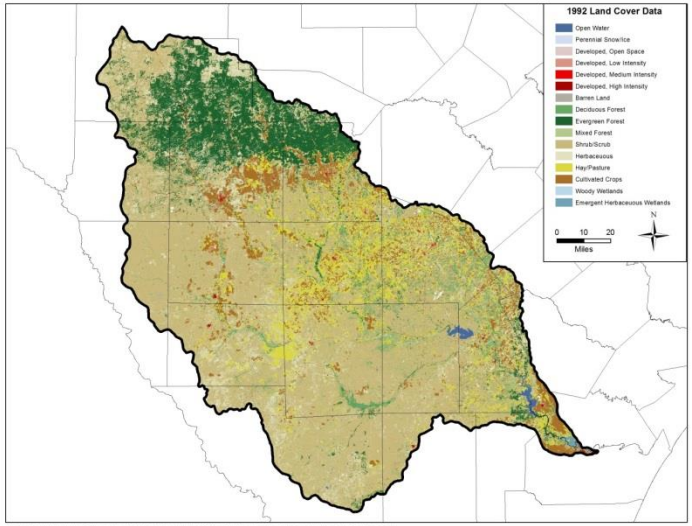
- Land Use
- Mission-Aransas Watershed
- Wastewater Treatment Plant Effects
- Effects of CCR Construction
- Annual Load Calculation for Dry, Average and Wet Years; Pre- and Post-CCR Construction

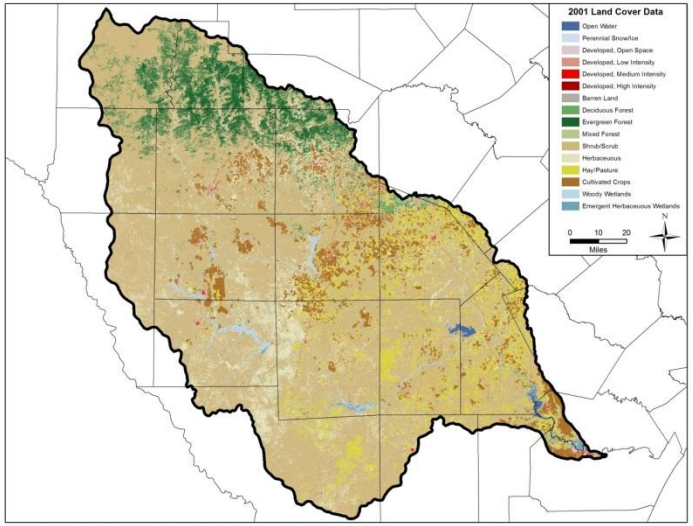
LAND USE ANALYSIS

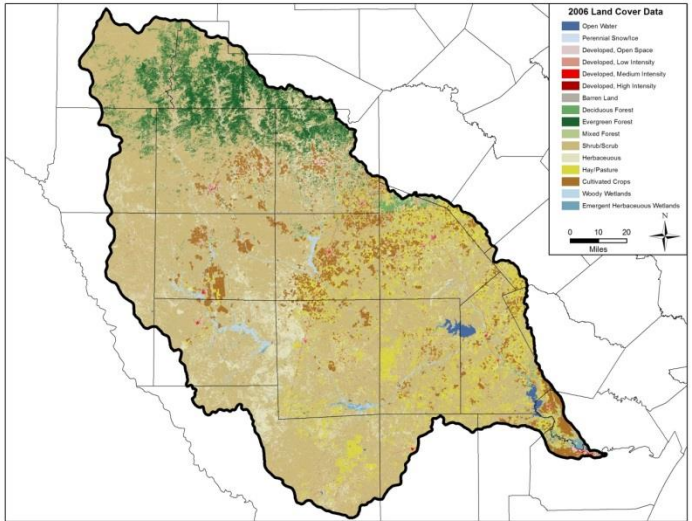
- Using NLCD to analyze land use changes over time

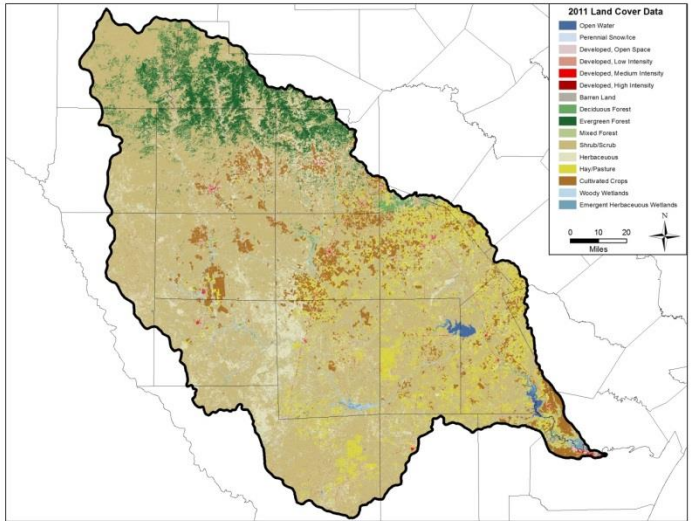
LAND USE

- About 4% increase in urban area over 1992-2011
- Cultivated acres relatively steady



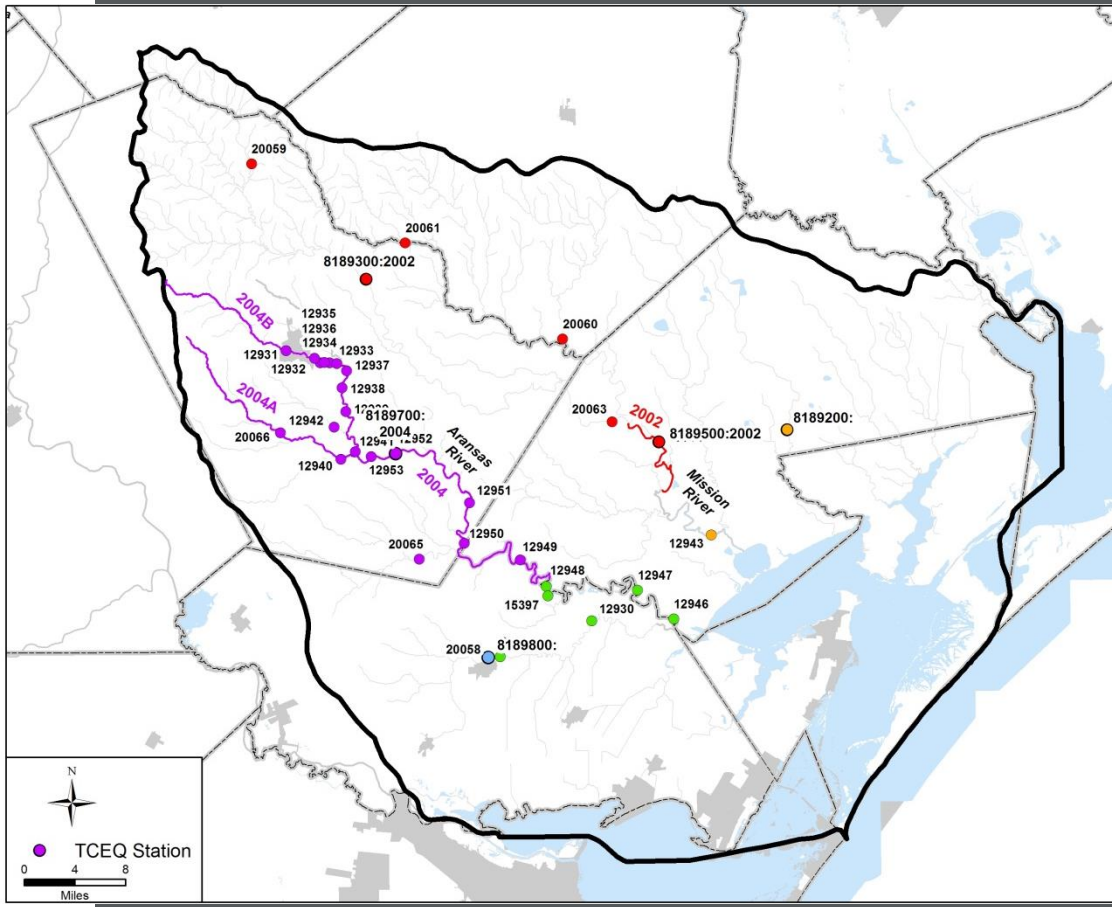






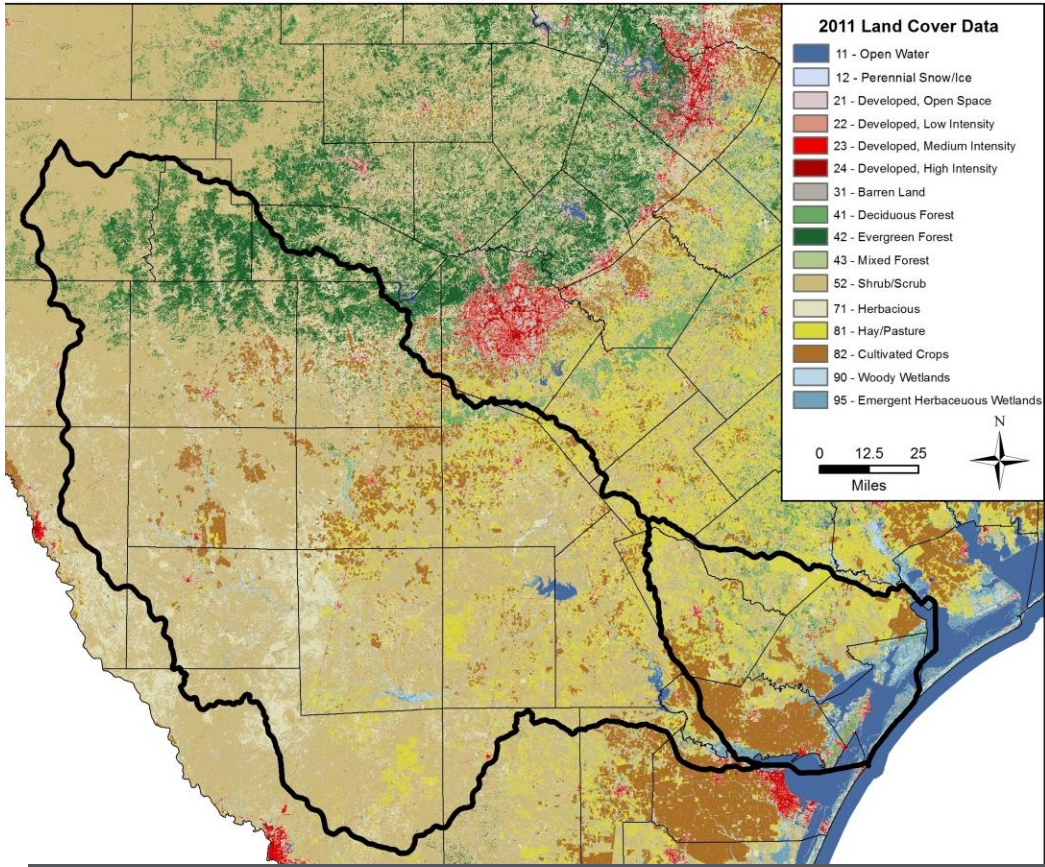
MISSION-ARANSAS WATERSHED ANALYSIS

- Very little development in watershed
- Hypothesized that M-A watershed would provide an additional evaluation as to whether changes in land use could be influencing water quality.

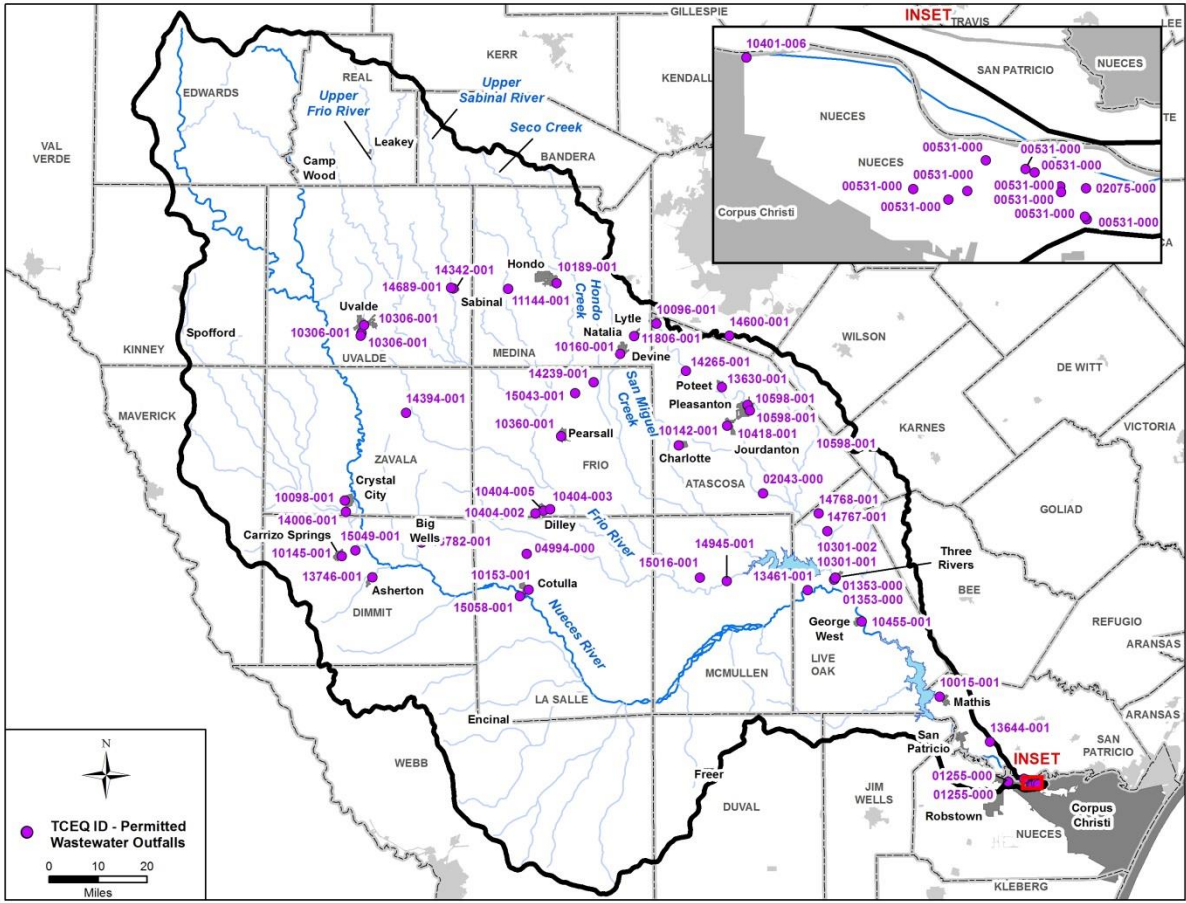


MISSION-ARANSAS WATERSHED ANALYSIS

- Upper Mission River had higher nutrient concentrations than upstream stations in less developed portions of Nueces
  - However, NO_x higher in Nueces compared to upper Mission River
  - Where comparisons possible, observed nutrient loadings in upper Aransas were even higher than observed in Mission River and upstream stations in the Nueces.
- One explanation for difference in nutrient loadings is land use in Aransas River subwatershed.
  - Land use is predominantly hay/pasture and cultivated crops

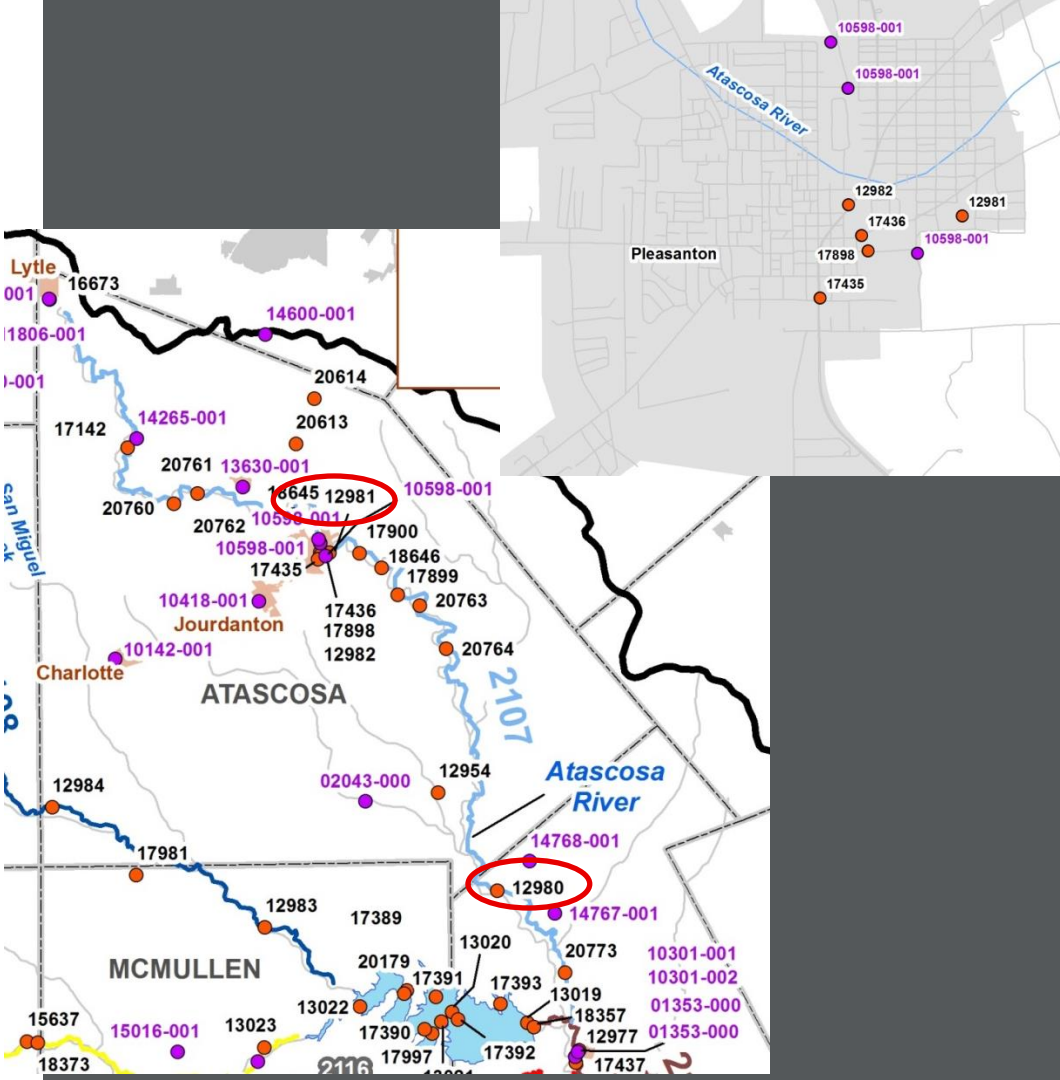


WWTP EFFECTS



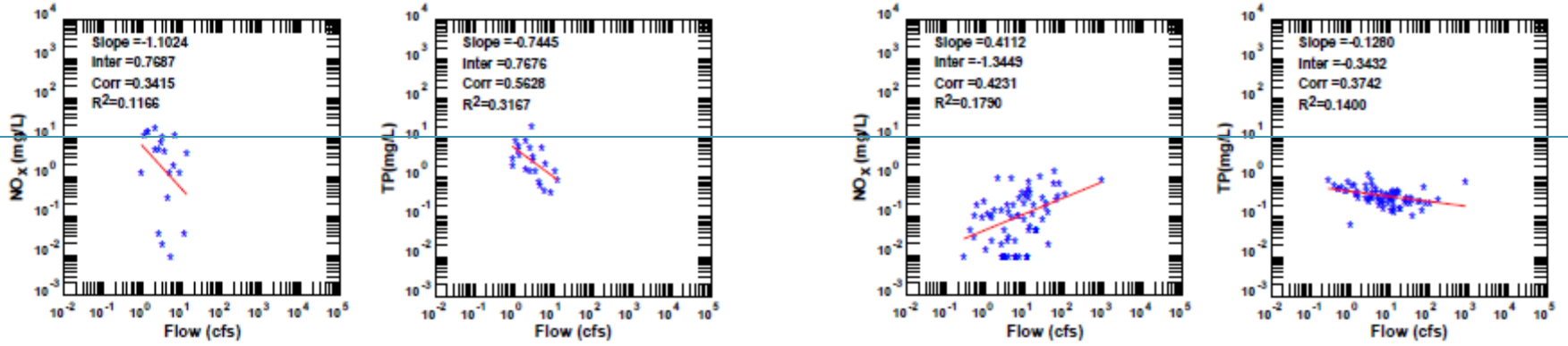
PLEASANTON EXAMPLE

- Station 12981, Atascosa River at Pleasanton
- NH_4, NO_x, TP, PO_4 and perhaps Chl-a higher at 12981 than 12980
- NRA BSR (2013a) states that much of upper Atascosa River is intermittent or ephemeral
  - If flows were not augmented by effluent from the Pleasanton WWTP outfall, river might be classified as intermittent, except for lowermost segment.



UPSTREAM TO DOWNSTREAM

- 12981 – Pleasanton
- 12980 – Downstream



Regression analysis, Station 12981

Nueces Tributaries, Texas (1970-2014)

Regression analysis, Station 12980

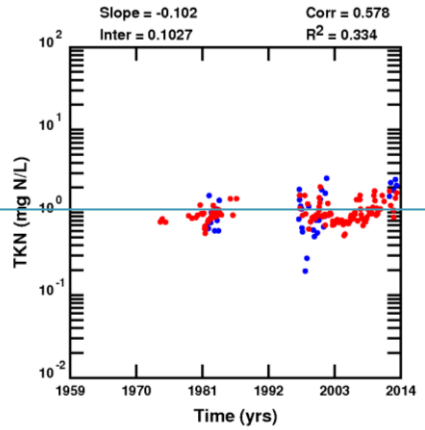
Nueces Tributaries, Texas (1970-2014)

DETERMINING THE EFFECTS OF CCR CONSTRUCTION

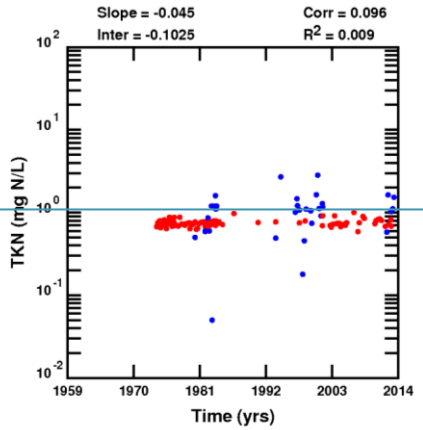
- Assumed data pre-1986 represented pre-construction and data post-1986 represented post-construction period
  - N species decline between pre- and post- reservoir construction
    - TKN decline may have begun prior to construction
  - TP and PO_4: Some increases in TP and PO_4 in the Frio River and San Miguel Creek post-construction that do not appear downstream of the reservoir at Three Rivers
  - Flow: Low flow conditions below CCR are greater than before CCR due to flow management

EFFECTS OF CCR - TKN

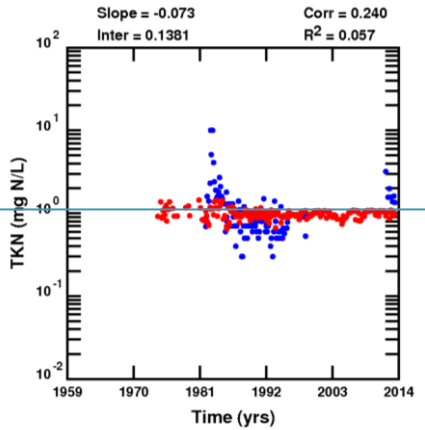
- TKN data from three TCEQ locations
  - Frio River at Tilden, Station 13023
  - San Miguel Creek nr Tilden, Station 12983
  - Three Rivers, Station 12979



Nutrient Distributions, Station 13023



Nutrient Distributions, Station 12983

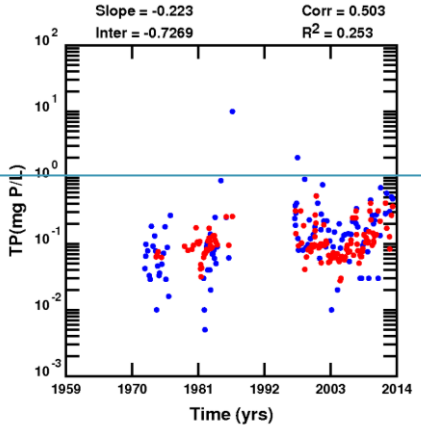


Nutrient Distributions, Station 12979

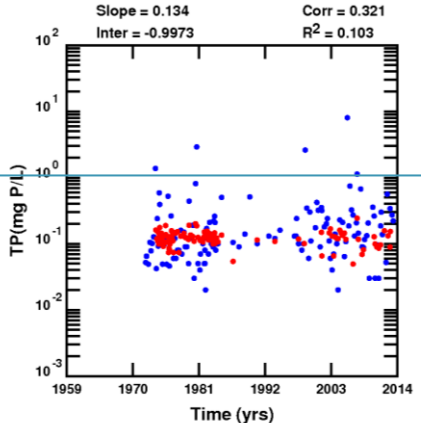
Observed Concentration
Estimated Concentration

EFFECTS OF CCR - TOTAL PHOSPHORUS

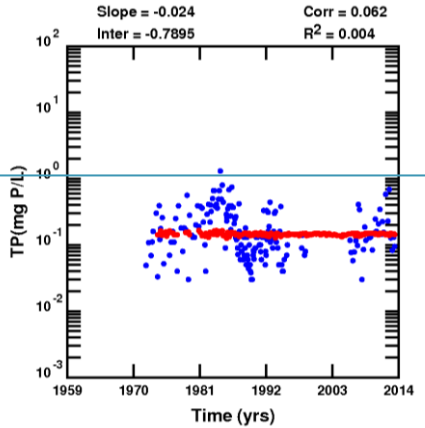
- Nutrient data from two TCEQ locations at
  - Frio River, Station ID 13023 (Figure 7-1) and
  - San Miguel Creek, Station ID 12983 (Figure 7-2)
  - Three Rivers, Station 12979



Nutrient Distributions, Station 13023



Nutrient Distributions, Station 12983



Nutrient Distributions, Station 12979

Observed Concentration
Estimated Concentration

ANNUAL LOAD CALCULATIONS

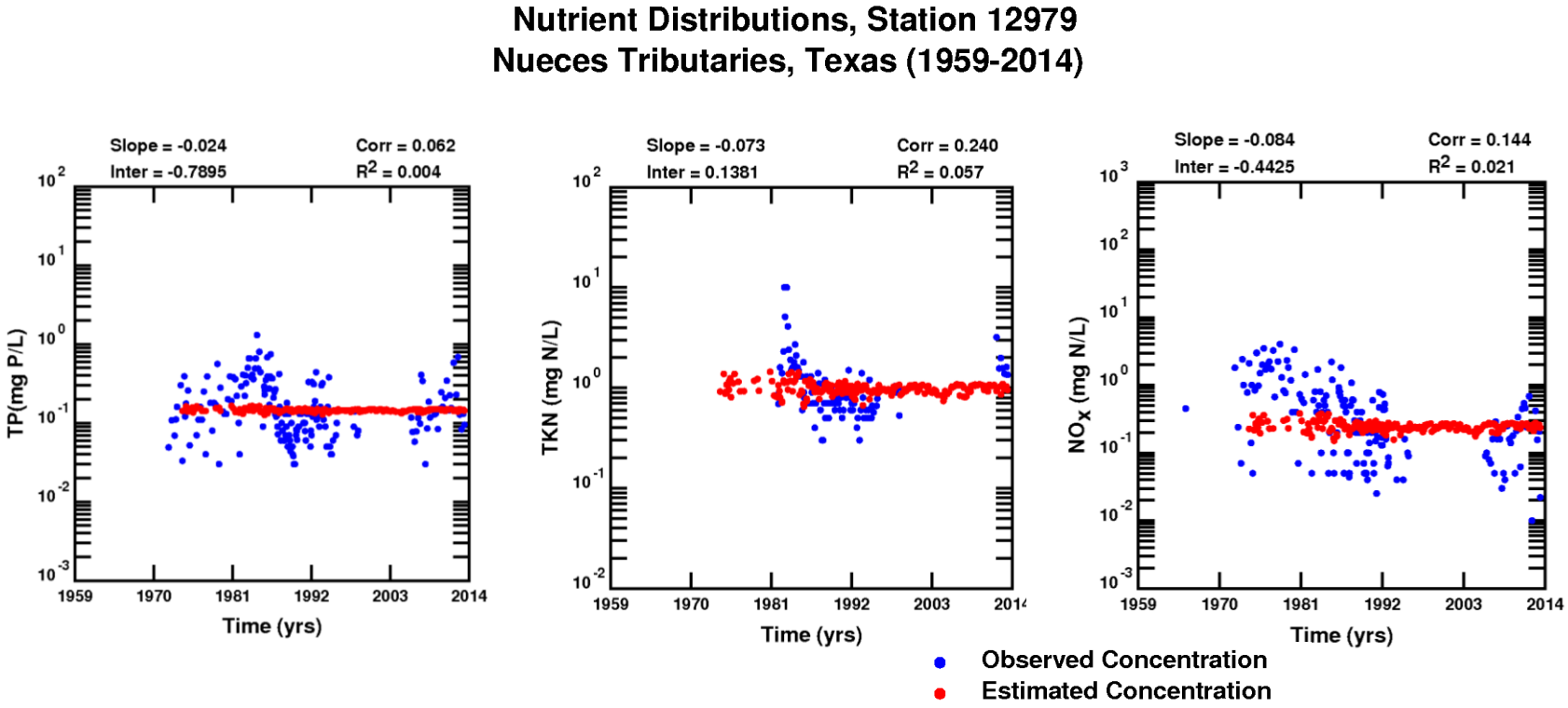
- Load = Concentration x Flow
- Concentration time-series
- Dry, average, wet years of USGS streamflow

Representative flow years based on
Nueces at Mathis (USGS 08211000, TCEQ 12965)

	Dry	Average	Wet
Pre-1986	1984	1974	1971
Post-1986	2008	1993	2002

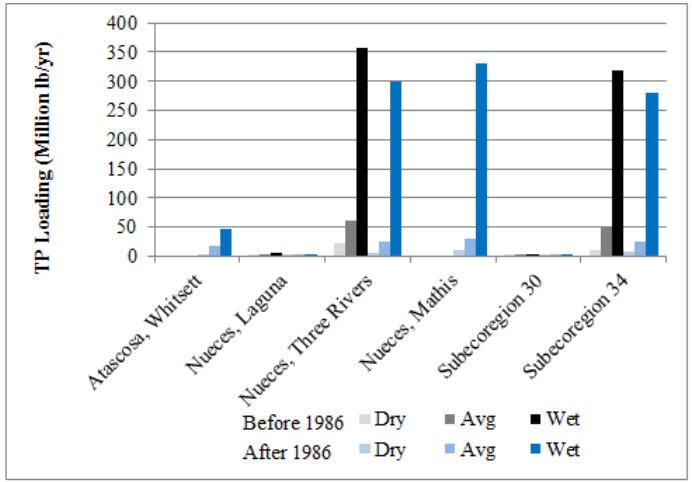
- Indication of nutrient load delivered to Estuary
- Also looked at dry, avg, wet years based on Calallen precip statistics

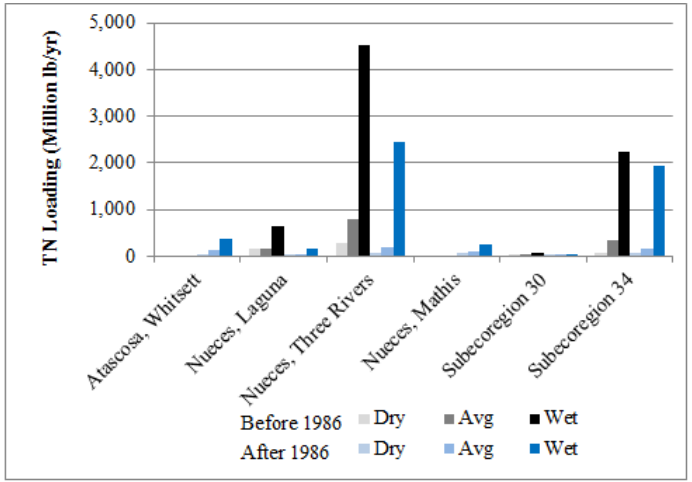
CONCENTRATION TIME-SERIES

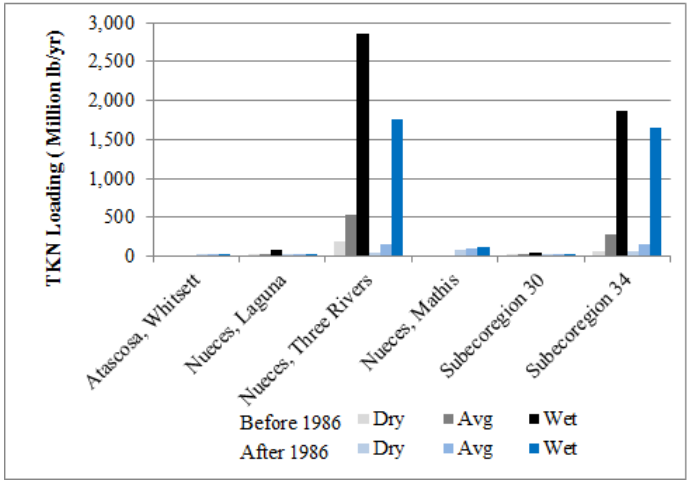


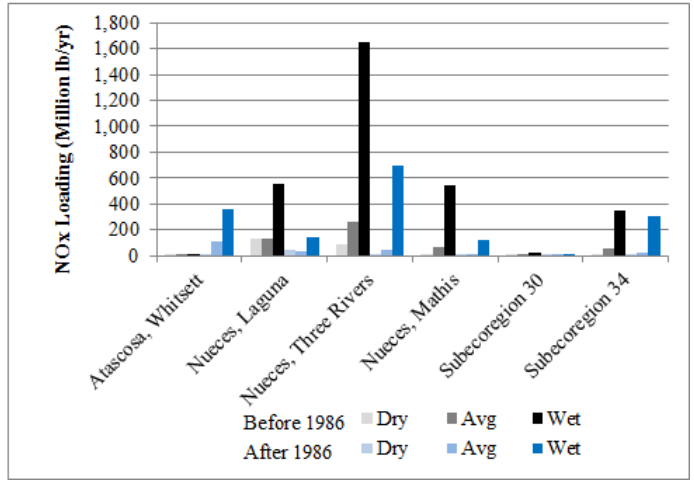
LOADS

- TP, TN, TKN, NOx

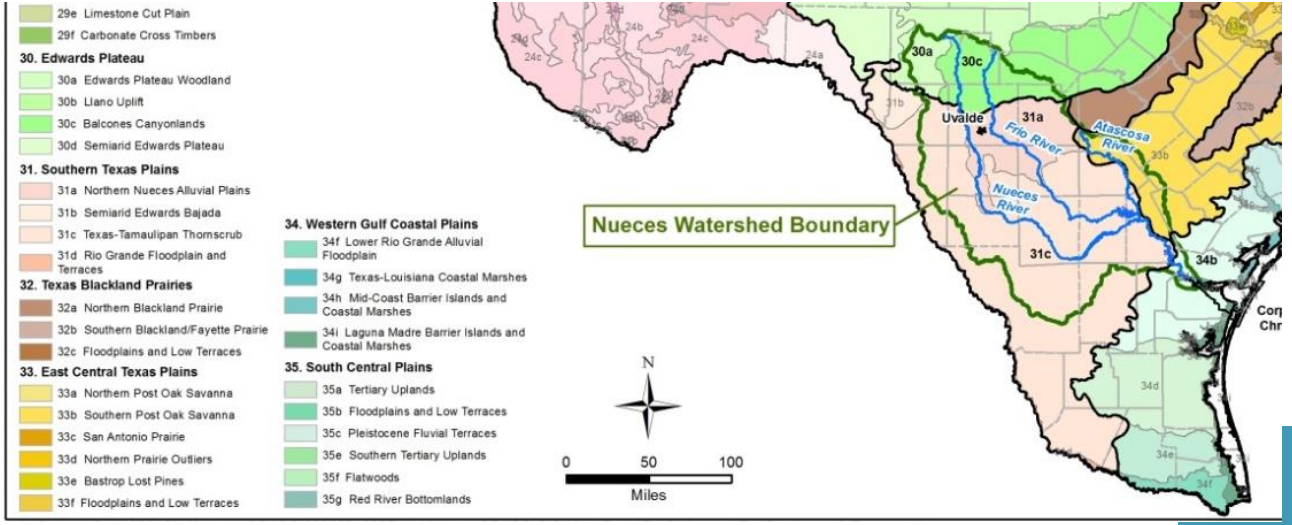








EPA ECOREGION REFERENCE CONDITIONS



Parameter	EPA 25th Percentile Reference Conditions			
(mg/L)	Ecoregion IV, Subecoregion 30[1]	Ecoregion IV, Subecoregion 31[2]	Ecoregion IX, Subecoregion 33[3]	Ecoregion X, Subecoregion 34[4]
Total Phosphorus	0.008	0.028	0.1	0.126
Total Kjedahl Nitrogen (TKN)	0.18	0.27	0.543	0.74
Total Nitrogen	0.27*, 0.55†	0.49*	0.681*, 0.935†	0.88*, 0.86†
Nitrite + Nitrate - N	0.09	0.22	0.138	0.14
Chlorophyll a**	0.002	0.002	0.000733	0.0021
Turbidity (FTU)	0.73	3.83	10.9	12.27

* Calculated

† Reported

** Chlorophyll a measured by Spectrophotometric method with acid correction

CONCLUSIONS

- Land use slowly changing. Urban areas increasing in size. Areas of cultivated crops seem to remain steady (1970 to present).
- Some locations are affected by WWTP discharge.
- Effects of CCR Construction
  - N species decline between pre- and post- reservoir construction
    - TKN decline may have begun prior to the construction
  - TP and PO_4: Appear to be some increases in TP and PO_4 in the Frio River and San Miguel Creek post-construction that do not appear downstream of reservoir at Three Rivers
  - Flow: Low flow conditions below CCR are greater than before CCR due to flow management
- Difficult to determine statistically significant relationships between flow and nutrients
  - Dataset is representative of a range of conditions.
  - Correlations could improve if they were done for specific temporal periods, rising or declining parts of hydrograph, or seasonally.

RECOMMENDATIONS

- Evaluate predictive scenarios of loadings upstream and downstream of CCR with CCR/LCC System operating under different operational schemes
- Evaluate effects of other development scenarios, including future build-out land use conditions, on nutrient loadings
- Quantify effects of seasonality on nutrient loadings.
- Further quantify effects of reservoirs in Nueces Watershed.
  - Fate and transport, nutrient processing uptake, losses, releases, dissolved oxygen
- Identify and quantify nonpoint source component of nutrient loadings in Nueces Watershed
  - One way to accomplish quantification of nonpoint source loadings is with watershed-scale nutrient loading model that takes into account point sources, as well as nonpoint sources.

TASK 3 – MEETINGS AND REPORT

- Task 3 – Meetings and Report
  - NEAC Kickoff Meeting June 16, 2014
  - NEAC Meeting Update October 20, 2014
  - NEAC Meeting Update February 23, 2015
  - NEAC Meeting Update June 22, 2015
  - Draft Report: June 30, 2015
  - Final Report, Contract Deadline: August 31, 2015

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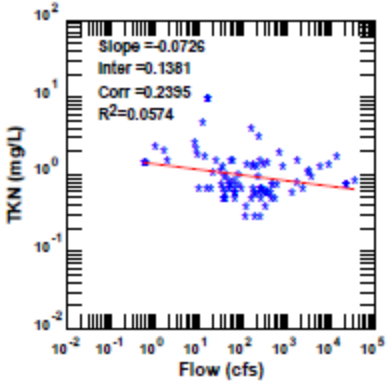
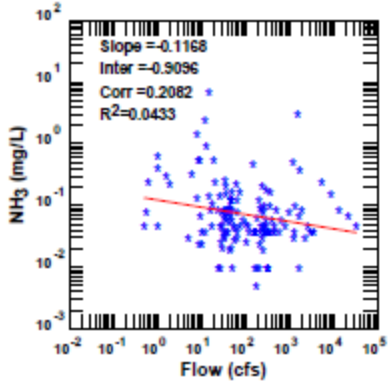
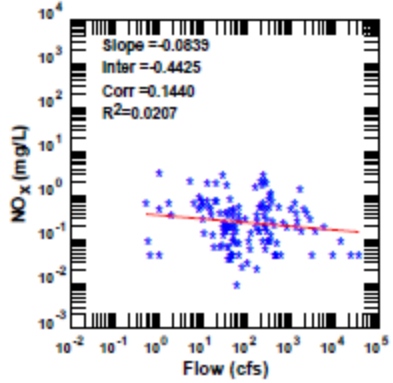
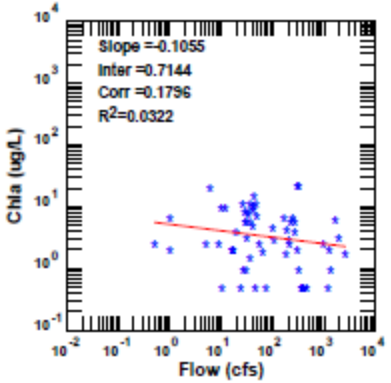
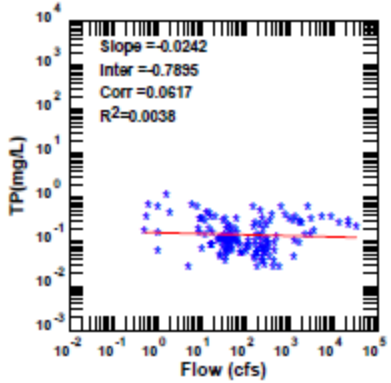
- Station 12999- Figure 4-14
- Station 12965-Appendix, Page 52
- Station 12979-Figure 4-15
- Station 12980-Figure 6-6
- Station 13024-Appendix, Page 61

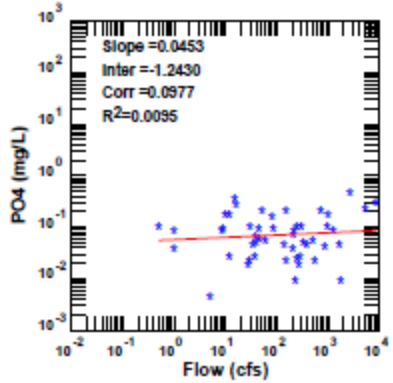












Regression analysis, Station 12979

Nueces Tributaries, Texas (1970-2014)

USGS_8190000 - Upstream Gage (unmanaged)			
average:	63,413		65,217
1970-1985 sorted		1986-2014 sorted	
1980	16,470	2011	7,332
1978	27,440	2014	8,406
1983	28,543	2013	14,342
1979	32,156	2009	17,004
1984	33,268	2012	17,169
1982	36,012	1989	19,500
1974	50,317	2006	22,038
1975	50,855	1993	23,700
1970	56,310	2008	26,594
1972	64,369	2010	31,279
1985	68,317	1995	33,684
1977	78,523	1988	36,329
1976	84,524	1994	40,524
1973	116,091	2005	56,935
1981	133,250	2003	57,389
1971	138,161	1999	58,364
		2002	58,460
		1986	63,850
		2000	84,151
		1990	85,830
		1996	86,082
		1991	97,526
		2001	111,889
		1998	121,648
		1992	128,554
		1997	131,474
		1987	146,386
		2007	149,315
		2004	155,525

USGS_8211000 - Downstream Gage (heavily managed)			
average:	300,975		174,663
geo mean	212,152	geo mean	106,381
1970-1985 sorted		1986-2014 sorted	
1984	47,248	2008	37,988
1983	54,263	2009	39,873
1982	105,443	2006	42,512
1978	112,263	2013	43,355
1972	150,368	2011	43,506
1970	180,665	2014	48,476
1979	183,261	2012	50,937
1975	188,417	2010	54,589
1974	196,536	1988	57,763
1985	236,812	2000	58,231
1977	266,578	1996	58,523
1980	283,516	1989	60,802
1976	467,987	1986	64,335
1973	525,632	1995	77,821
1981	532,307	1991	92,005
1971	1,284,308	1994	93,991
		1999	100,190
		1993	101,551
		2005	113,366
		1997	125,382
		2001	130,139
		1998	168,851
		1990	177,480
		2003	256,412
		1987	381,824
		2004	452,732
		1992	466,299
		2007	539,718
		2002	1,126,578

Calallen Precip gage (suburb of Corpus)			
average:	35		30
1970-1985 sorted		1986-2014 sorted	
1982	22.77	2011	12.66
1977	26.55	1989	16.65
1984	26.89	1996	19.01
1974	27.58	1988	19.33
1975	29.69	2012	19.51
1978	31.55	2009	20.84
1980	32.61	2008	23.15
1970	33.92	2013	25
1972	34.69	2005	25.08
1979	37.14	2000	25.9
1983	37.87	2014	27.08
1985	39.65	2006	27.54
1971	40.71	1999	27.87
1976	43.55	1990	27.97
1973	45.46	1986	29.51
1981	45.76	2001	32.14
		1987	32.33
		2003	33.03
		1995	33.11
		1994	33.73
		1993	34.95
		1998	36
		2004	38.56
		2002	39.34
		1991	41.58
		1992	41.82
		2007	42.59
		1997	43.12
		2010	43.55